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ASSESSING THE DIETARY EFFECTS OF THE FOOD STAMP PROGRAM

VOLUME II: EMPIRICAL RESULTS

FINAL REPORT

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EXECUTIVE SUMMARY

This study is an assessment of the dietary effects of the Food Stamp Program (FSP). Volume I of this study is a conceptual design for an analysis of the dietary effects of the FSP, and Volume II presents empirical results from the estimation of econometric models of the dietary effects of the FSP. This model is based on the economic theory of consumer demand and relates nutrient levels to the food stamp benefit, cash income, and other relevant household characteristics.

In its most basic form, the proposed dietary model is conceptually straightforward and fairly simple to estimate. This basic model is estimated with household food use data from the 1979-80 Survey of Food Consumption in Low-Income Households. The dietary components examined are the household availability of the following nutrients: food energy, protein, vitamin A, vitamin C, thiamin, riboflavin, vitamin B_6, calcium, phosphorus, magnesium, and iron.

The principal findings from the estimation of the basic model are:

- o Increases in both FSP benefits and cash income are associated with increases in household availability of nutrients.

- o The estimated marginal effects of the food stamp benefit consistently exceed those of cash income. Specifically, estimates of the change in household nutrient availability due to a one-dollar increase in the food stamp benefit are 3 to 7 times the comparable estimates for cash income.

In addition to the basic model, two econometric models of selection bias are estimated for this study. Selection bias may occur because FSP participants may differ from other low-income households in ways that may make it difficult to isolate the dietary effects of FSP participation. The results of the selection bias models show little evidence of selection bias, and the estimated dietary effects of the food stamp benefit and cash income from the selection bias models are quite similar to those from the basic model.

Several additional technical econometric issues and model extensions are considered in Volume I of this report. They include:

- o Multiple program participation. Because low-income households are able to participate in more than one program at a time, it is important to consider the impact of multiple program participation in analyses that want to isolate the effects of FSP participation.

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- Household versus individual-level FSP effects. The basic household model is modified to examine the intra-household allocation of FSP benefits.

- Functional form of the nutrient equations and specification testing. Given the long history of the food expenditure literature that shows the importance of considering different functional forms for models of food expenditure, it is important to examine carefully alternative functional forms for dietary models and to conduct specification tests to determine the best functional form.

- Scaling for household size and composition. Given that household size and composition are important predictors of household food expenditures and nutrient levels, models of dietary effects of the FSP need to consider the variety of household scaling procedures used in previous analyses.

- Dietary status versus nutritional status. It is important to note that dietary status is not synonymous with nutritional status, which is the focus of the FSP's objectives. A thorough determination of nutritional status involves a combination of dietary assessments, anthropometric measurements, clinical evaluation, and biochemical tests. While a study of the dietary effects of the FSP cannot be used to draw conclusions concerning the effects of the FSP on nutritional status, a thorough dietary status assessment is an integral complement to anthropometric, clinical, and biochemical assessments.

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I. INTRODUCTION

In its current form, the FSP has as its mandate "to safeguard the health and well-being of the nation's population by raising the level of nutrition among low-income households." The program is designed to raise the level of nutrition through the provision of in-kind income in the form of coupons that legally can be used only to purchase food. This report is the second volume of a study assessing the dietary effects of the FSP. Volume I of this study is a conceptual design for a dietary analysis of the FSP. The major product of that analysis is an econometric model of the effects of FSP benefits on dietary outcomes. The objectives of this volume are twofold: (1) to present empirical results from the estimation of the model specified in Volume I; and (2) to interpret the results obtained from this analysis in conjunction with the findings from previous studies to assess our current knowledge of the dietary effects of the FSP.

This report is organized in four chapters. The remainder of this chapter reviews the basic model of the dietary effects of the FSP developed in Volume I and discusses the data used in the analysis. Chapter II presents the results of estimating the basic model of household nutrient availability and compares the results of this study to previous findings. The third chapter presents and interprets empirical results from extensions of the basic econometric model, and a brief summary chapter concludes the report.

A. REVIEW OF BASIC MODEL

The model of the dietary effects of the FSP developed in Volume I is based on the Engel function, which relates changes in the consumption of a good to changes in income. The Engel function is typically used in analyses of food expenditures based on cross-sectional data and is derived from the theory of consumer demand. That is, households have preferences for consumption goods, represented by a utility function, and choose consumption bundles by maximizing utility subject to a budget constraint.

Specifically, assume that the household chooses from J different goods Q_j, j=1,..., J, and a composite nonfood good C. Maximizing utility subject to the availability of resources leads to demand functions for food goods:

$$(1.1) \qquad Q_j = f_j(P_1, P_2, \ldots, P_J, Y, B),$$

where P_j is the normalized price of food good j, Y is total household income, and B is the food stamp benefit. This model can be extended to examine the demand for nutrients. Let a_{kj} denote the amount of nutrient k (k=1,2,...,K) contained in each unit of food good Q_j. Then the intake of nutrient k is the following:

$$(1.2) \qquad N_k = \sum_{j=1}^{J} a_{kj} Q_j \qquad k = 1, \ldots, K$$

Equations (1) and (2) constitute a structural model of the determinants of nutrient levels. An increase in income or the FSP benefit level, for example, increases the quantity of each food good consumed (Q_j), although some may fall if they are inferior goods. Each Q that changes causes a change in the amount of each nutrient, the amount depending upon the magnitudes of the a_{kj}'s.

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A major issue discussed in Volume I of this study is how to estimate the structural model depicted by equations (1) and (2). The simplest and most straightforward method is by direct estimation of the reduced-form equations. Substituting equation (1.1) into equation (1.2) leads to demand functions for nutrients of the following form:

$$(1.3) \qquad N_k = g_k(P_1, P_2, \ldots, P_J, Y, B)$$

Assuming that prices are constant in a cross-sectional data set and recognizing that other variables affect the demand for food goods, linear regression equations of the following form can be specified for each of the K nutrients:

$$(1.4) \qquad N_{ki} = \alpha_k + \beta_k Y_i + \delta_k B_i + X_i \phi_k + \varepsilon_{ki},$$

where X is a set of other variables hypothesized to affect the demand for food goods and, hence, nutrient levels, and ε is a random error term. The coefficients β and δ in this equation represent the combined effects of (1) the effect of income and the food stamp benefit on the demand for food goods and (2) the effect of food consumption on nutrient levels (the a_{kj}'s). The two effects cannot be separated out, but this is not necessary to determine the effect of the FSP. The key point is that the coefficients correctly capture the effects of income and the food stamp benefit on nutrient levels working through the hundreds of individual food goods, even though those individual food consumption levels are not used in the estimation.

In its most basic form, the model depicted by equation (1.4) is straightforward and simple to estimate using ordinary least squares (OLS) regression. However, several technical econometric issues and model extensions are considered in this study in order to account for possible confounding factors in estimating the dietary effects of the FSP. The results of estimating the basic model and extensions to the basic model are presented in Chapters II and III of this report, respectively.

B. DESCRIPTION OF DATA

The data used in this report are from the 1979-80 Survey of Food Consumption in Low-Income Households (SFC-LI). This survey was conducted from November 1979 through March 1980 for a national probability sample of approximately 2,900 low-income housekeeping households eligible to receive benefits under the FSP.[1] It was comparable to the 1977-78 Low-Income Supplement to the Nationwide Food Consumption Survey (NFCS-LI), which was conducted from November 1977 through March 1978 for a national probability sample of approximately 4,400 low-income housekeeping households. The objective of the 1979-80 SFC-LI was to provide information on changes in food use and dietary adequacy that were associated with increasing food prices and the elimination of the purchase requirement (EPR) in January 1979.

The sample design for the 1979-80 SFC-LI is a national probability sample of households in the 48 coterminous states that were eligible to participate in the FSP. Within each of the Primary Sampling Units selected, reporting districts were stratified by three income levels--less

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[1] Housekeeping households are households with at least one person having 10 or more meals from household food supplies during the 7 days preceding the interview.

than 20 percent of households with incomes below poverty, 20-29 percent, and 30 percent or more. A total of 1,134 area segments was selected for interviewing. Onsite listings of current residences were made for each area segment and a random sample of these residences was selected. Sample weights were assigned to each of the sample cases such that the weighted sample is representative of the population of low-income households in the U.S.[1]

The 1979-80 SFC-LI provides detailed information on household food use. Household food use refers to food and beverages used from household food supplies during the seven days preceding the interview. Food purchased with cash, credit, or food stamps and food that was home-produced, received as a gift or payment for work, or received through other food programs are all included in the measure of household food use.

It is important to note that household food use is not equivalent to food intake by individuals in the household or to household diets. Food intake refers to food actually eaten and is generally less than food used. The difference between the amount of food used and actual food intake can be attributed to food waste or loss and food provided to pets. Differences in survey methodologies for obtaining data on food used and food intake and reporting errors also may contribute to observed differences between food used and food intake.[2]

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[1] The weighting factors used in the analysis have a mean of 1.01 and a standard deviation of 2.32. They range from a low of .051 to a maximum of 39.7.

[2] Food intake surveys usually cover 1 to 3 days (compared to 7 days for food use surveys) and are less likely to include weekend days when consumption is relatively high.

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The survey methodology was based on a seven-day recall of food used from household food supplies. Respondent households had been contacted at least seven days prior to the actual interview and asked to maintain records of shopping lists, menus, grocery receipts, prices of food, and labels that would help them provide information on food use. For each food item used from household food supplies during the previous seven days, the interviewer recorded the type of food, form (fresh, canned, or frozen), quantity used, price paid (if appropriate), and source (purchased, home-produced, or gift or pay). Data were also collected on the number and type of meals (morning, noon, or evening) eaten from household food supplies by guests, and on meals (but not foods) eaten away from home by household members. In addition to the data on food use, information was obtained on household characteristics presumed to be related to food use, such as participation in the FSP, participation in other food assistance programs (School Lunch, School Breakfast, and WIC), household consumption, income, education and employment of the household heads, urbanization, and tenancy.

Data on household food energy and nutrient availability are calculated from the quantity of each food item used from household food supplies. Caloric and nutrient contents of each food item are obtained from tables of the nutritive value of foods.[1] Total household availability

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[1] The sources for the nutritive values are B. Watt and A. Merrill, "Composition of Foods...Raw, Processed, Prepared." U.S. Department of Agriculture, Agricultural Handbook 8 (revised), 1963; the supplements to the Agricultural Handbook (8-2, 1976; 8-2, 1977; and 8-3, 1978); and M.L. Orr, "Pantothenic Acid, Vitamin B_6 and Vitamin B_{12} in Foods," U.S. Department of Agriculture, Home Economic Research Report No. 36, 1969. Some values in these reports were revised by the Nutrient Data Research Branch to HNIS to reflect the current state of knowledge of nutritive values.

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of food energy is derived by summing the food energy of the individual food items used. The household availability of nutrients is obtained in similar fashion by summing the nutritive values of the individual food items. Nutritive values pertain to the edible portion of the food used from household food supplies, with some adjustments for vitamin losses during preparation.

Two crucial features of the data from the 1979-80 SFC-LI are important to note. First, the data are household-level data. While information is collected on each individual food item used, no information is available on which household member or other person eating from household food supplies used which food item. Second, household nutrient availability data are based on food used from household food supplies. Nutritive values are not available for food eaten away from home. If the number of meals eaten away from home differs among groups of households, differences in nutrient availability will be observed regardless of whether or not any differences exist in the nutritive value of food used at home. Therefore, it is important to make an adjustment for the proportion of meals eaten at home when comparing nutrient availability from food used at home by subgroups of low-income households. In addition, just as food used exceeds food intake, nutrient availability overstates nutrient intake.[1]

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[1] As discussed in Volume I of this report, neither nutrient availability nor nutrient intake are synonymous with nutritional status. For a more complete discussion of nutritional status, see Appendix B of Volume I.

II. EMPIRICAL RESULTS: BASIC MODEL

This chapter presents the results of estimating the basic model of nutrient availability using household food use data from the 1979-80 Survey of Food Consumption in Low-Income Households (SFC-LI). As discussed in Chapter I and in more detail in Volume I of this report, the theoretical model underlying the effects of the FSP on nutrient availability suggests the estimation of reduced-form nutrient equations. The equations include all determinants of the consumption of food goods; therefore it should include the amount of income from various sources as well as individual and household characteristics that affect food consumption. The basic model estimated for each nutrient is the following:

$$N_i = \alpha + \beta_1 Y_i + \beta_2 Y_i^2 + \delta B_i + X_i \phi + \epsilon_i, \tag{2.1}$$

where N_i is the availability of the particular nutrient for household i, B is the value of the food stamp benefit, Y is the value of cash income, and X is a vector of household characteristics. The food stamp benefit and cash income are not only allowed to have separate coefficients, but cash income is also entered in quadratic form to allow for a decreasing effect of changes in income on food consumption as income increases. Ordinary least squares (OLS) is used to estimate (2.1) separately for each nutrient. The coefficients should be interpreted as representing the net effects of each variable on the consumption of individual food goods and the consequent effects on nutrient availability.

Table II.1 shows the means of the major variables used in the empirical analysis. Eleven major nutrients are examined, and each is

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TABLE II.1

MEANS OF THE VARIABLES USED IN THE ANALYSIS
(N = 2,925)

Variable	Mean Value
Nutrients per ENU	
Food Energy (Kcal)	3,988
Protein (mg)	129
Vitamin A (IU)	11,414
Vitamin C (mg)	139
Thiamin (mg)	2.71
Riboflavin (mg)	3.23
Vitamin B_6 (mg)	2.56
Calcium (mg)	1,000
Phosphorus (mg)	1,710
Magnesium (mg)	464
Iron (mg)	16.9
Income per AME ($)	
Cash Income	$47.23
Food Stamp Benefit[a]	5.42
Food Stamp Benefit-Participants only	10.84
Subsidy Value of School Lunches	1.25
Subsidy Value of School Breakfasts	.17
Value of Home-Grown Food	.53
Value of Gift/Pay Food	.88
Household Characteristics	
FSP Participation Rate	.50
AME (food energy)	2.63
Female Head	.94
Guest Meals per AME	.75
North Central	.14
South	.67
West	.08
Spanish	.07
Suburban	.15
Nonmetropolitan	.37
Head of Household 35-59	.35
Head of Household 60+	.32
Black	.49

SOURCE: 1979-80 Survey of Food Consumption in Low-Income Households.

NOTE: Unweighted data were used.

[a]Includes zeros for nonparticipants.

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scaled by the number of equivalent nutrition units in the household. The number of equivalent nutrition units (ENUs) is one measure of household size and is defined as the number of adult equivalent males eating meals from household food supplies. It adjusts actual household size for both the age-sex composition of family members and guests and the proportion of weekly meals eaten at home. The adjustment procedure weights each household member by (1) the nutritional requirements of that member relative to the nutritional requirements of an adult male aged 23-50, where the nutritional requirements are based on the 1980 Recommended Dietary Allowances (RDA) for each nutrient, and (2) the proportion of weekly meals eaten at home.[1] This second part of the weighting scheme is important for analyses of nutrient availability since, as noted in Chapter I, such nutrient data are based only on food used at home. Thus, the ENU adjustment is required not only for the differing age-sex compositions of each household but also because only food used at home is measured.

The income variables shown in Table II.1 are scaled by the number of adult male equivalents (AME), based on the RDA for food energy.[2] These are representative amounts only, for in our regression equations, AMEs are defined separately for each nutrient, based on the RDA for the individual nutrients. The means of the nutrient-specific scaled income amounts are shown in Appendix A. The overall income patterns are the same regardless

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1. [illegible]

of which scaling measure is used--cash income is about eight times larger than the average FSP benefit overall. However, the average food stamp benefit per AME for participants only is $10.84, which is roughly 28 percent of cash income for participating households (not shown).

The other variables shown in Table II.1 indicate that, on average, $2.83 per adult male equivalent was from foods received either through the school nutrition programs, as gift or pay, or from home-grown food. The low-income sample was divided about evenly between FSP participants and nonparticipants, between blacks and non-blacks, and by age of the household head (<35, 35-59, 60+). In addition, average household size was 2.63 adult male equivalents, the vast majority of the households had a female head present (94 percent), and the sample was located largely in the South and in rural or nonmetropolitan areas.[1]

A. OLS RESULTS

Table II.2 shows the OLS estimates of equation (2.1) for each nutrient. The most striking result shown in the table is that the estimated marginal impacts of the food stamp benefit consistently and significantly exceed those of cash income. While the estimates indicate positive and statistically significant effects on nutrient availability for both the food stamp benefit and cash income, the coefficient on the linear cash income variable is always less than the coefficient on the food stamp benefit.

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[1] The mean values presented in Table II.1 are unweighted means. "Female head present" refers either to households with a female head only or to households with both a male and female head.

TABLE 11.2

OLS ESTIMATES OF EQUATIONS FOR THE AVAILABILITY OF NUTRIENTS IN FOOD USED FROM HOME FOOD SUPPLIES:
U.S. LOW-INCOME HOUSEHOLDS, 1979-80

(Standard Errors in Parentheses, N = 2,925)

Explanatory Variables	Food Energy	Protein	Vitamin A	Vitamin C	Thiamin	Riboflavin	Vitamin B_6	Calcium	Phosphorus	Magnesium	Iron
Constant	2,951*	104.79**	7,640**	110.85*	1.890**	2.579**	2.355**	907**	1,518**	407.7**	13.168**
	(238)	(7.17)	(1,230)	(13.45)	(.166)	(.194)	(.155)	(73)	(104)	(27.9)	(1.093)
Household Weekly Food Stamp Benefit Per Adult Male Equivalent[a]	52**	1.81**	156**	1.97**	.040**	.052**	.039**	18**	30**	7.1**	.387**
	(6)	(.18)	(31)	(.41)	(.004)	(.005)	(.004)	(2)	(3)	(.7)	(.044)
Household Weekly Money Income Per Adult Male Equivalent[a]	16**	.59**	39**	.90**	.010**	.012**	.011**	6**	11**	2.1**	.161**
	(4)	(.11)	(20)	(.25)	(.0025)	(.003)	(.002)	(1)	(2)	(.4)	(.026)
Household Income Per Adult Male Equivalent Squared[a]	-.06**	-.003**	-.17	-.004*	-.00004**	-.00005**	-.00006**	-.03*	-.06*	-.009**	-.0008**
	(.02)	(.001)	(.13)	(.002)	(.000015)	(.00002)	(.00002)	(.01)	(.02)	(.003)	(.0002)
Weekly Subsidy Value of School Lunches Per Adult Male Equivalent[a]	64*	3.75**	78	6.71**	.073**	.060**	.102**	7	20	9.7**	.570**
	(27)	(.72)	(129)	(1.52)	(.019)	(.022)	(.017)	(11)	(16)	(3.1)	(.206)
Weekly Subsidy Value of School Breakfasts Per Adult Male Equivalent[a]	122	3.37	292	3.42	.078	.080	.075	61	109*	12.6	.467
	(77)	(2.10)	(372)	(4.52)	(.053)	(.063)	(.049)	(32)	(45)	(8.9)	(.626)
Weekly Value of Home-Grown Food Per Adult Male Equivalent[a]	195**	6.59**	1,105**	8.87**	.122**	.152**	.128**	70**	139**	26.4**	1.399**
	(21)	(.69)	(119)	(1.45)	(.015)	(.018)	(.016)	(8)	(12)	(2.8)	(.145)
Weekly Value of Gift/Pay Food Per Adult Male Equivalent[a]	83**	3.23**	343**	5.53**	.056**	.070**	.076**	30**	49**	10.6**	.557**
	(15)	(.48)	(83)	(1.05)	(.011)	(.013)	(.011)	(6)	(9)	(2.0)	(.108)
Female Head Present	-59	-2.31	2,124**	11.55	-.018	.054	-.138	-160**	-279**	-16.2	-4.195**
	(134)	(4.01)	(680)	(7.21)	(.093)	(.108)	(.085)	(39)	(56)	(15.5)	(.621)
Black	-41	5.28*	3,763**	24.53**	-.019	-.196**	.103*	-167**	-143**	-47.0**	.776*
	(74)	(2.20)	(373)	(3.94)	(.051)	(.059)	(.047)	(21)	(31)	(8.5)	(.335)
Number of Adult-Male-Equivalent Persons in Household[a]	-140**	-4.13**	-938**	-9.98**	-.073**	-.090**	-.090**	-15**	-37**	-13.4**	-.403**
	(26)	(.81)	(135)	(1.24)	(.018)	(.021)	(.017)	(5)	(.8)	(2.9)	(.060)
Number of Guest Meals Per Adult Male Equivalent[a]	29	1.55**	147	1.66	.013	.026*	.023*	9	30**	4.4*	.354**
	(16)	(.48)	(83)	(1.04)	(.011)	(.013)	(.011)	(6)	(9)	(2.0)	(.112)
North Central	-23	-7.49	-1,069	-16.30*	.088	-.042	-.194*	-21	-57	-19.0	.960
	(134)	(4.01)	(681)	(7.20)	(.094)	(.108)	(.085)	(39)	(56)	(15.5)	(.613)
South	366**	-7.30**	-1,182*	-16.70**	.324**	.049	-.168*	63	136**	-7.9	1.767**
	(113)	(3.38)	(574)	(6.07)	(.079)	(.091)	(.072)	(33)	(47)	(13.1)	(.515)

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Table II.2 (continued)

Explanatory Variables	Food Energy	Protein	Vitamin A	Vitamin C	Thiamin	Riboflavin	Vitamin B_6	Calcium	Phosphorus	Magnesium	Iron
West	-60 (148)	-8.54 (4.43)	-620 (752)	-3.23 (7.95)	.099 (.103)	-.080 (.120)	-.130 (.094)	35 (43)	8 (62)	15.2 (17.2)	1.089 (.677)
Spanish	581** (132)	17.27** (3.95)	1,417* (670)	37.00** (7.08)	.473** (.092)	.365** (.106)	.354** (.084)	39 (38)	111* (55)	19.6 (15.3)	2.898** (.603)
Suburban	-184 (96)	-4.45 (2.86)	-1,194* (485)	-15.34** (5.12)	-.151* (.067)	-.112 (.077)	-.132* (.061)	-40 (28)	-81* (40)	-22.1* (11.1)	-1.145** (.437)
Nonmetropolitan	33 (76)	-3.56 (2.28)	-1,848** (387)	-19.02** (4.09)	.019 (.053)	-.041 (061)	-.118* (.049)	35 (22)	31 (32)	.13 (8.83)	-.068 (.348)
Head of Household is 35 to 59 Years Old	179* (78)	6.40** (2.35)	1,465** (399)	10.85** (4.16)	.126* (.054)	.110 (.063)	.007 (.050)	63** (23)	133** (33)	15.3 (9.1)	2.140** (.357)
Head of Household is 60 Years Old or Over	5 (92)	-8.55** (2.67)	1,496** (453)	5.86 (4.81)	-.068 (.063)	-.096 (.073)	-.268* (.057)	34 (26)	4 (38)	-23.6* (10.3)	2.230** (.446)
R^2	.12	.12	.13	.10	.09	.09	.12	.12	.16	.11	.25
Mean of Dependent Variable	3,998 Kcal	128.57 mg	11,414 IU	139.22 mg	2.715 mg	3.231 mg	2.560 mg	1,000 mg	1,710 mg	464 mg	17 mg

SOURCE: 1979-80 Survey of Food Consumption in Low-Income Households.

NOTE: The dependent variables are daily availability per equivalent nutrition unit (number of equivalent adult males eating from home food supplies). Equivalent nutrition units are computed separately for each nutrient.

[a]The number of adult male equivalents is computed separately for each nutrient.

*(**) Significant at the .05(.01) level.

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This point is examined in more detail in Table II.3. The first two columns show the "MPCs" (i.e., the marginal propensity to "consume" nutrients for the food stamp benefit and for cash income). The cash income MPCs are evaluated at the mean of cash income, and therefore represent the average MPC in the sample. As the table indicates, the MPCs for the food stamp benefit are much greater than the cash income MPCs. The ratio of MCP for the food stamp benefit to the cash income MPC is never less than 3 and is as high as 7. This is a very large difference, and one which is discussed in more detail in section B of this chapter.

To obtain some feel for whether the estimated dietary effects are large or small, the third and fourth columns of Table II.3 show the MPCs as a percentage of the adult male RDA. The percentage effects of changes in cash income are quite low, ranging from .3 to 1.2 percent of the adult male RDA. With the exception of food energy and Vitamin B_6, the effects of the food stamp benefit are, interestingly, very close for most nutrients. That is, nutrient availability increases from between 2.0 and 3.9 percent of the RDA for a one-dollar increase in the food stamp benefit per AME for most of the nutrients examined. The implications of these findings are twofold. First, increases in the food stamp benefit are generally allocated proportionally among the nutrients examined. Second, the effect of the food stamp benefit on the availability of food energy is less in percentage terms than for most of the other nutrients, suggesting that increases in FSP benefits result in household diets with higher nutrient density.

The final two columns in Table II.3 show the estimated total availability of nutrients (as opposed to marginal changes) attributable to the food stamp benefit and cash income. These "total effects" are

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TABLE II.3

MARGINAL PROPENSITIES TO CONSUME NUTRIENTS
AND IMPLIED TOTAL EFFECTS

	Absolute MPC		MPC as a Percentage of the Adult Male RDA		Total Effects[a]	
	Food Stamp Benefit	Cash[a]	Food Stamp Benefit	Cash[a]	Food Stamp Benefit	Cash
Food Energy (Kcal)	52.0	11.0	1.9%	.4%	564	530
Protein (mg)	1.81	.36	3.2	.6	19	18
Vitamin A (IU)	156	25	3.1	.5	1,691	1,256
Vitamin C (mg)	1.97	.59	3.3	1.0	21	29
Thiamin (mg)	.040	.006	2.9	.4	.434	.328
Riboflavin (mg)	.052	.008	3.3	.5	.564	.390
Vitamin B_6 (mg)	.039	.007	1.8	.3	.423	.336
Calcium (mg)	18	4	2.3	.5	195	187
Phosphorus (mg)	30	7	3.8	.9	325	336
Magnesium (mg)	7.1	1.4	2.0	.4	77	68
Iron (mg)	.387	.115	3.9	1.2	4.195	5.038

SOURCE: 1979-80 Survey of Food Consumption in Low-Income Households.

NOTES: Absolute MPC = Change in nutrient availability per ENU due to a one-dollar change in income per AME. Percentage MPC = Absolute MPC divided by 1984 adult male RDA for the particular nutrient.

[a]Evaluated at mean cash income per AME.

calculated by multiplying the estimated coefficients on the food stamp benefit, cash income, and cash income squared (all scaled by AME) by their respective average values for the benefit level and cash income for program participants. Except for vitamin C, phosphorous, and iron, the total availability of nutrients attributed to FSP benefits is either very close to or exceeds the availability of nutrients due to cash income. Indeed, even for those three nutrients where nutrient availability attributable to household cash income is greater than that due to FSP benefits, the differences are not very large. Given that the average food stamp benefit is only 28 percent of the average value of cash income for FSP participants ($10.84 versus $38.76), these findings are consistent with the conclusions drawn from examining the estimated MPCs--that is, that the estimated effects of an additional dollar of the food stamp benefit on nutrient availability exceed the estimated effects of an additional dollar of cash income.

Returning to Table II.2, we see that the subsidy value of school lunches and school breakfasts both have positive effects on nutrient availability, although the latter is usually not statistically significant. The weekly value of home-grown and gift/pay food are also positively and significantly associated with nutrient availability and, in fact, the estimated coefficients on these two variables are significantly larger than the estimated coefficients on both the food stamp benefit and cash income variables. The number of AMEs in the household lowers nutrient availability per ENU, reflecting economies of scale in food use. Nutrient patterns vary across region as well as by suburban and metropolitan residence, the two stratification variables used in the survey design.

B. COMPARISON OF RESULTS WITH PREVIOUS FINDINGS

As shown in Tables II.2 and II.3 and discussed above, the OLS results show large and statistically significant differences between the estimated coefficients of the food stamp benefit and cash income in the nutrient availability equations. The ratio of the MPC for the food stamp benefit to the MPC for cash income ranges from a low of 3 to a high of 7. The magnitude of these differences prompted us to examine more carefully the comparable results from previous studies to determine if our findings are consistent with those in the literature or if they are peculiar to our model specification or data set used in the analysis.

Although several studies have examined the dietary effects of the FSP, only two studies used data sources and had dietary outcome variables comparable to those in this analysis. The results of these two studies, as well as of our study, are presented in Table II.4. It is important to note that the two previous studies used different model specifications, estimation procedures, and units of measurement; consequently, adjustments to the basic empirical results of these studies were necessary to make those findings comparable to ours. For example, both the Allen and Gadson study and the Basiotis et al. study used weekly (versus daily) nutrient availability, so the estimated coefficients were divided by seven to handle the difference in the units of measurement. In addition, the Basiotis et al. study had a model specification quite different than the specified model for this study, and it is not possible to calculate estimated MPCs for the food stamp benefit based on that model specification. It is possible, however, to calculate estimated total impacts of the FSP, and these are presented in the table.

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TABLE II.4

COMPARISON OF EMPIRICAL RESULTS WITH TWO PREVIOUS STUDIES

Study	Food Energy (kcal)	Protein (mg)	Vitamin A (IU)	Vitamin C (mg)	Thiamin (mg)	Riboflavin (mg)	Vitamin B_6 (mg)	Calcium (mg)	Phosphorus (mg)	Magnesium (mg)	Iron (mg)
Devaney, Moffitt, Haines[a]											
MPC-income	11	.36	25	.59	.006	.008	.007	4	7	1.4	.115
MPC-FSP benefit	52	1.81	156	1.97	.040	.052	.039	18	30	7.1	.387
Total Effects-FSP	564	19	1,691	21	.434	.564	.423	195	325	77	4.195
Allen and Gadson (1983)[b]											
MPC-income	7	.33	48	.87	.003	.007	.008	2	4	1.3	.055
MPC-FSP benefit	49	1.64	164	2.42	.030	.091	.037	16	33	6.1	.322
Basiotis et al. (1983)[c]											
MPC-income (including food stamp benefit)	6	.29	18	.70	.003	.008	n.a.	3	n.a.	n.a.	.047
Total effects-FSP	381	9	1,064	73	.203	.023	n.a.	-25	n.a.	n.a.	1.495

[a]Based on data from the 1979-80 Survey of Food Consumption in Low-Income Households.

[b]Based on data from the 1977-78 Low-Income Supplement to the NFCS. The estimates presented are weighted averages of the estimates for the rural and non-rural South from the study.

[c]Based on data from the 1977-78 Low-Income Supplement to the NFCS.

A comparison of the findings from this study and those from the Allen and Gadson study show that the results are generally similar. In particular, both studies report much higher MPCs for the food stamp benefit than for cash income, and the magnitudes of the estimated coefficients are roughly the same across the two studies (with some exceptions). In addition, the estimated MPCs for cash income from the Basiotis et al. study are comparable in magnitude to those from this study, despite fundamental differences in model specification.

However, the estimates of the total effects of the FSP from this study are quite different from the comparable estimates from the Basiotis et al. analysis. With the exception of vitamin C, the estimated total effects of the FSP presented in this report are considerably larger than those reported by Basiotis et al. This is most likely due to a model specification of that study in which the household income variable included the food stamp benefit, thus constraining the marginal effects of cash income and the food stamp benefit to be the same. Since the results of our study strongly suggest differential effects of cash income and the food stamp benefit on nutrient availability, with larger MPCs for the food stamp benefit, the inclusion of the bonus in an overall household income measure leads to underestimates of the dietary effects of FSP benefits.

In summary, the results presented in this chapter show large and significant differences between the dietary effects of cash income and FSP benefits. These findings have also been reported in previous studies, although only two studies have used a framework similar enough to that used in this analysis to permit a comparison of the findings. It is also possible that the basic model of nutrient availability estimated in this chapter ignores several important factors that may confound the estimated

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relationships between nutrient availability, cash income, and FSP benefits. The following chapter considers extensions to the basic model specified and estimated above.

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III. EXTENSIONS OF BASIC MODEL

The reduced-form nutrient equations estimated in the previous chapter are a critical first step in assessing the dietary impacts of the FSP. However, selection bias may confound the estimated relationship between nutrient availability and the food stamp benefit. Selection bias may occur because of unobserved differences between FSP participants and eligible nonparticipants that cannot be captured by measurable variables in the equation, but which are related to the propensity of a household to participate in the FSP. This chapter presents estimates from two models of nutrient availability that account for the self-selection of FSP households.

A. ECONOMETRIC MODELS OF SELECTION BIAS

The issue of selection bias often arises in the analysis of the effects of the FSP on food expenditure and nutrient availability. Most generally, the selection bias problem arises if those households that choose to receive FSP benefits were high (or low) food-expenditure or nutrient-availability households to begin with, even before participation in the FSP and even if they had not participated in the FSP. Our major interest in this issue focuses on two questions: (1) does adjustment for selection bias affect the magnitude of the FSP benefit coefficient, and (2) does adjustment for selection bias affect the large differences between the dietary effects of FSP benefits and cash-income obtained with the unadjusted models above?

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To address these issues, we estimate two different selection bias models. The first tests for the existence of what we term Type A selection bias, and is represented by the two-equation model:

$$(3.1) \quad N_{ki} = \alpha_k + \beta_k Y_i + \delta_k B_i + X_i \phi_k + \varepsilon_i$$

$$(3.2) \quad P_i^* = Z_i \Psi + \nu_i$$

$$(3.3) \quad P_i = 1 \text{ if } P_i^* \geq 0;$$

$$= 0 \text{ if } P_i^* < 0$$

where P_i^* is an index for the "propensity" to participate in the FSP, and Z_i is a set of variables that affect that propensity. Included in Z_i must be, among other things, the potential food stamp benefit and cash income.[1] The dummy variable P is one if a household actually participates in the program and zero if not.

This selection bias model has been used before in the literature on the food expenditure effects of the FSP by, for example, Chen (1983) and Beebout et al. (1985). The main direct indicator of selection bias in this model is the magnitude and statistical significance of the estimated correlation between the two error terms in the model, ε_i and ν_i. That correlation indicates whether those households with, for example, above-

[1] Specifically, the variables used as predictors of the likelihood of participating in the FSP are: weekly cash income; potential food stamp benefit; race of the household head (1=black, 0=nonblack); dummy variables for whether the household has a male head only or a female head only; dummy variables for the age, education, and employment status of the female household head (or male household head if there is no female head); and a dummy variable for whether the household owns their home.

average nutrient availability even in the absence of the FSP (i.e., high ε_i) are also more likely to participate in the FSP (i.e., high ν_i). If so, the correlation is positive. If the above-average nutrient-availability households are less likely to participate in the FSP, the correlation will be negative. We report estimates below of (3.1)-(3.3) using a full information maximum likelihood estimation procedure.

The second model of selection bias allows a different form of correlation, which is a correlation between the value of the MPC of a household and its participation in the FSP. We term this type of selection bias Type B selection bias and address it by the following model:

$$(3.4) \quad N_i = \alpha + \beta_i(Y_i+\gamma B_i) + X_i\phi + \varepsilon_i$$

$$(3.5) \quad \beta_i = W_i\lambda + w_i$$

$$(3.6) \quad P_i^* = Z_i\Psi + \nu_i$$

$$(3.7) \quad P_i = 1 \text{ if } P_i^* \geq 0; \quad = 0 \text{ if } P_i^* < 0$$

In this model the nutrient equation contains a single income term, $Y+\gamma B$, which is equal to total income if $\gamma=1$. The coefficient on this income variable, β_i, is the MPC for income in general, and it has a "i" subscript to represent the fact that it is allowed to be different for different households. In particular, this specification allows for the possibility of different MPCs for FSP participants and eligible nonparticipants. As shown in equation (3.5), the MPC for income is assumed to be a function of a set of variables denoted by W_i and by an unobserved error term, w_i.[1]

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Equations (3.6) and (3.7) are the same type of participation equation as before.

In this model, selection bias takes place if the error terms w_i and ν_i are correlated. If, for example, they are positively correlated, this implies that those households who have high MPCs even in the absence of the FSP (high w_i) are more likely to participate in the FSP. If negatively correlated, they are less likely to participate in the FSP. This can be seen more directly by substituting equation (3.5) into equation (3.4) to obtain the equation:

$$(3.8) \quad N_i = \alpha + \lambda(Y_iW_i) + \lambda\gamma(B_iW_i) + X_i\phi + \eta_i$$

$$\eta_i = \varepsilon_i + (Y_i + \gamma\beta_i)w_i$$

Here we see that the error term in the equation, η_i, contains w_i because those households with a high MPC (high w_i) will have higher nutrient availability levels, other things held constant. Therefore if w_i and ν_i are correlated, selection bias will result.

In our estimation of this model, we also allow the error terms ε_i and ν_i to be correlated. Thus, we allow the Type A selection bias to be included in the same model. They are different types of selection bias, because in one case (Type A) we are testing for whether households with different levels of nutrient availability are more or less likely to be FSP participants, whereas in the other (Type B) we are testing for whether the

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[1] The set of variables assumed to influence the MPC for cash income are race, household size in adult-male-equivalent persons, number of guest meals eaten from home food suppliers per adult male equivalent, dummy variables for the age (<35, 35-59, 60+) of the female household head (male head if there is no female head), and dummy variable for whether the household lives in the South or in a suburban location.

change in availability per dollar of income per AME is greater or smaller for FSP participants.

One of our main interests in the estimation of this model is whether the estimate of γ is or is not equal to 1, where the coefficient γ is the estimated ratio of the MPC for the food stamp benefit to the cash-income MPC. As mentioned before, the OLS estimates of this ratio ranged from 3 to 7. It is possible that that ratio was affected by Type B selection bias, however, because it could be that those who are FSP participants have higher MPCs, in the first place, out of both income and food stamp benefits. Our estimates of the Type B selection bias model will indicate whether this is indeed the case.

B. RESULTS

Given the complexity of selection bias models discussed above, we estimated these models for only five of the nutrients: food energy, vitamin A, vitamin B_6, calcium, and iron. These five dietary components were chosen because these nutrients generally have the lowest average availability levels relative to the RDA and the lowest percentage meeting the RDA.

Table III.1 shows the results of the important parameter estimates of the Type A selection bias for the five dietary components. Focusing first on the estimates of the cross-equation correlation estimates, we see that the evidence for Type A selection bias is not strong. Of the five estimates, only one is statistically significant (vitamin B_6), and that estimated correlation coefficient is not large.

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TABLE III.1

TYPE A SELECTION BIAS RESULTS: SELECTED NUTRIENTS

(Standard Errors in Parentheses, N=2,925)

	Food Energy	Vitamin A	Vitamin B_6	Calcium	Iron
Coefficients:					
Food Stamp Benefit/AME	59.0** (7.0)	196.6** (38.4)	.046** (.0053)	13.8** (3.1)	.471** (.050)
Cash Income per AME	18.0** (1.3)	40.5** (1.03)	.012** (.001)	5.55* (.096)	.177** (.016)
Cash Income per AME Squared	-.066** (.022)	-.16 (.21)	-.00006** (.00002)	-.029* (.015)	-.0009** (.003)
MPC					
Food Stamp Benefit	59.0	196.6	.046	13.8	.471
Cash[a]	11.7	26.3	.007	3.6	.122
Cross-Equation Correlation Coefficient	-.041 (.034)	-.051 (.035)	-.069* (.035)	-.047 (.034)	-.062 (.035)

SOURCE: 1979-80 Survey of Food Consumption in Low-Income Households.

*(**): Significant at .05(.01) level.

[a]Evaluated at mean cash income per AME.

The significant correlation estimate is, however, negative, implying that there is a tendency for households with lower availability of vitamin B_6 to be FSP participants. The result is that the estimated MPC for the food stamp benefit for vitamin B_6 (.046) is somewhat higher than that estimated previously (.039), as can be seen by comparing Table III.1 with the prior results in Table II.3. In addition, the gap between the FSP benefit and cash-income MPCs for vitamin B_6 widens slightly after the correction for Type A selection bias.

Table III.2 presents the estimates from the model of Type A and Type B selection bias. In this table, we show estimates of: (1) the two correlation parameters, ρ_1 for the conventional Type A selection bias and ρ_2 for the new Type B selection bias; (2) the ratio of the bonus MPC to the cash-income MPC, γ; and (3) the MPC for the food stamp benefit and for cash income. As the results indicate, the estimated correlation parameters are all statistically insignificant, implying that there is no evidence of either type A or type B selection bias. As a result, the estimated bonus and MPCs for the food stamp benefit and for cash income are quite similar to the OLS estimates that were reported in Chapter II.

In addition, and indirectly reflecting the statistical insignificance of the correlation parameters, the estimates of γ in the model exceed one for all five nutrients. Thus, the finding that the MPC for the food stamp benefit is significantly larger than the cash-income MPC persists even with complex statistical models that account for the potential confounding factor of the self-selection of FSP households.

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TABLE III.2

TYPE A AND B SELECTION BIAS RESULTS: SELECTED NUTRIENTS

(Standard Errors in Parentheses)

	Food Energy	Vitamin A	Vitamin B_6	Calcium	Iron
γ: Ratio of Food Stamp Benefit to Cash-Income MPC	3.13** (.29)	3.39** (.32)	5.77** (.77)	2.43** (.25)	1.97** (.18)
ρ_1: Cross-Equation Correlation Coefficient, Type A	-.022 (.085)	-.011 (.096)	-.126 (.081)	.059 (.084)	-.010 (.073)
ρ_2: Cross-Equation Correlation Coefficient, Type B	-.022 (.116)	-.072 (.146)	.047 (.167)	.016 (.122)	-.011 (.089)
Implied MPC-Food Stamp Benefit	56.6**	175**	.052**	13.0**	.365**
Implied MPC-Cash Income[a]					
FSP Participants	16.9**	50**	.009**	5.5**	.188**
Eligible Nonparticipants	18.4**	55**	.009**	5.0**	.188**

SOURCE: 1979-80 Survey of Food Consumption in Low-Income Households.

*(**): Significant at the .05(.01) level.

[a]Evaluated at mean cash income per AME.

IV. SUMMARY

This report is the second of a two-volume study assessing the dietary effects of the FSP. This second volume presents empirical estimates from models of nutrient availability. The basic model estimated for this study relates changes in the availability of nutrients to changes in cash income and the food stamp benefit. Potential biases associated with the self-selection of FSP households are considered by developing two extensions to the basic model that account for the participation decision of FSP-eligible households.

The major finding of this empirical analysis is that the estimated dietary effects of changes in FSP benefits are considerably larger than those due to changes in cash income. The estimated ratios of the MPC for the food stamp benefit to the cash-income MPC are consistently and significantly greater than one. The OLS estimates of these ratios range from 3 to 7, and the estimates from the selection bias models for selected nutrients range from roughly 2 to 6.

An additional finding of interest is that there is no evidence of selection bias. Two econometric models of selection bias are estimated for this study. Type A selection bias tests for whether households with different initial levels of nutrient availability are more or less likely to be FSP participants, while Type B selection bias tests for whether the change in nutrient availability per dollar of cash income is greater or smaller for FSP participants relative to eligible nonparticipants. The results of the selection bias models show little evidence of either type of selection bias, and the estimated dietary effects of the food stamp benefit

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and cash income from the selection bias models are very similar to those from the basic model estimated by OLS regression.

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APPENDIX A

MEASURES OF HOUSEHOLD COMPOSITION AND CALCULATION OF ADULT MALE EQUIVALENT PERSONS AND EQUIVALENT NUTRITION UNITS

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A consistent finding of previous research based on food use data is that household size and composition have important effects on food expenditures and nutrient availability. Larger households and households with certain types of members (e.g., teenaged males) have been found to consume greater quantities of food, resulting in higher food expenditures and greater nutrient availability than is found for households of other sizes and/or composition. Three basic measures of household composition are used in research on food use data:

1. Household size
2. Household size in adult-male-equivalent (AME) persons
3. Household size in equivalent nutrition units (ENU)

The first measure of composition--household size--is simply the number of persons in the household and is the easiest measure to use in analyses of food expenditures and nutrient availability. It is typically adjusted to 21-meal-at-home equivalent persons to account for differences in the number of meals eaten at home (21 meals-at-home in a week equals one person). One problem with household size and household size in 21-meal-at-home persons is that all household members are treated identically and thus, the age and sex of the household members are assumed unrelated to the amount of food use. This assumption is questionable since it is likely that variations in either food expenditures or nutrient availability can be attributed in part to the age and sex, as well as the number, of household members. For example, a household consisting of a woman and two children has different nutritional requirements (and hence, is likely to have

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different food expenditures) than a household of similar size with three adult males.

The second measure of composition--household size in adult-male-equivalent persons--adjusts actual household size for the age and sex of the household members. The adjustment procedure weights each household member by the nutritional requirements of that member relative to the nutritional requirements of an adult male aged 23-50.[1] The sum of these weights gives household size in adult-male-equivalent persons. For example, consider the following household with a male and female head each aged 30, a boy aged 15, and a girl aged 12:

Household Member	Requirements for Food Energy (Kilocalories)	Relative Needs
Male, aged 30	2700	1.00
Female, aged 30	2000	.74
Male, aged 15	2800	1.04
Female, aged 12	2200	.81
Household size in adult-male-equivalent persons		3.59

The number of adult-male-equivalent persons in this household, based on the relative needs of the household members for food energy is 3.59. Household size in adult-male-equivalent persons is used as a scale for the income variables used as independent variables for the analysis reported in Volume

[1] These requirements are obtained from the 1980 Recommended Dietary Allowances (RDA), which were determined by the National Research Council of the National Academy of Sciences.

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II. Table A.1 presents mean values for the nutrient-specific adult-male-equivalent persons and scaled income variables.

The final measure of composition--household size in equivalent nutrition units--is the number of adult equivalent males in the household eating meals from the household food supplies. It adjusts actual household size for both the age-sex composition of the family members and the proportion of meals eaten away from home. Continuing with the previous example, suppose the male head ate two-thirds of his weekly meals at home and the other household members ate all their meals at home:

Household Member	Relative Needs		Proportion of Meals Eaten at Home		Equivalent Nutrition Units
Male, aged 30	1.00	x	.67	=	.67
Female, aged 30	.74	x	1.00	=	.74
Male, aged 15	1.04	x	1.00	=	1.04
Female, aged 12	.81	x	1.00	=	.81
Household size in equivalent nutrition units					3.26

Household size in equivalent nutrition units for this hypothetical household, based on the relative needs for food energy, is 3.26 persons. Equivalent nutrition units are used as scales for the nutrient availability variables for this analysis, and mean values of the nutrient-specific equivalent nutrition units and scaled availability variables are presented in Table A.2.

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TABLE A-1

MEAN VALUES FOR NUTRIENT-SPECIFIC AME AND
SCALED INCOME VARIABLES

	Food Energy	Protein	Vitamin A	Vitamin C	Thiamin	Riboflavin	Vitamin B_6	Calcium	Phosphorus	Magnesium	Iron
AME	2.63	2.59	2.65	3.08	2.63	2.70	2.76	3.67	3.65	2.77	4.74
Income Per Ame ($/Week)											
Cash Income	$47.23	$44.19	$43.40	$36.83	$45.68	$44.32	$40.63	$33.83	$33.96	$41.47	$29.28
Food Stamp Benefit[a]	5.42	5.36	5.24	4.33	5.33	5.19	4.94	3.78	3.81	5.01	3.06
Food Stamp Benefit-Participants	10.84	10.72	10.48	8.66	10.66	10.38	9.88	7.56	7.62	10.02	6.12
Subsidy Value of School Lunches	1.25	1.35	1.30	1.13	1.26	1.23	1.25	.89	.89	1.23	.70
Subsidy Value of School Breakfasts	.17	.19	.18	.16	.18	.17	.18	.12	.12	.17	.10
Value of Home-Grown Food	.53	.49	.48	.42	.52	.50	.46	.39	.39	.46	.35
Value of Gift/Pay Food	.88	.83	.82	.68	.85	.83	.77	.63	.63	.79	.53

SOURCE: 1979-80 Survey of Food Consumption in Low-Income Households.

[a]Includes zeros for nonparticipants.

TABLE A-2

MEAN VALUE FOR NUTRIENT-SPECIFIC ENU AND
SCALED NUTRIENT AVAILABILITY VARIABLES

	ENU	Daily Availability Per ENU
Food Energy	2.27	3.988 Kcal
Protein	2.26	129 mg
Vitamin A	2.31	11,414 IU
Vitamin C	2.70	139 mg
Thiamin	2.28	2.71 mg
Riboflavin	2.33	3.23 mg
Vitamin B_6	2.41	2.56 mg
Calcium	3.17	1,000 mg
Phosphorus	3.15	1,710 mg
Magnesium	2.41	464 mg
Iron	4.14	16.9 mg

SOURCE: 1979-80 Survey of Food Consumption in low-income households.